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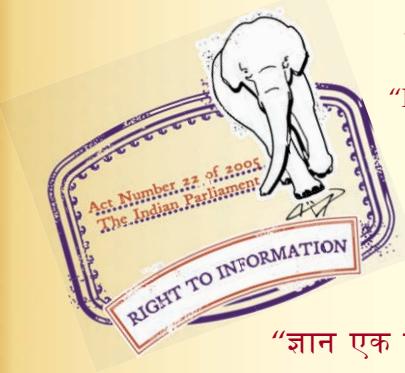
“Step Out From the Old to the New”

IS 11145 (2002): Plain Bearings -- Thin Walled Half-Bearings -- Checking of Peripheral Length [PGD 13: Bearing]

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परिधीय लम्बाई की जाँच करना  
( पहला पुनरीक्षण )

*Indian Standard*  
PLAIN BEARINGS — THIN-WALLED HALF-  
BEARINGS — CHECKING OF PERIPHERAL LENGTH  
( *First Revision* )

ICS 21.100.10

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**BUREAU OF INDIAN STANDARDS**  
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## NATIONAL FOREWORD

This Indian Standard ( first revision ) which is identical with ISO 6524 : 1992 'Plain bearings — Thin-walled half-bearings — Checking of peripheral length' issued by the International Organization for Standardization ( ISO ) was adopted by the Bureau of Indian Standards on the recommendations of the Plain Bearings Sectional Committee and approval of the Basic and Production Engineering Division Council.

This standard was originally published in 1984. This revision of the standard has been made by adoption of ISO 6524 : 1992 under dual numbering system.

The text of the ISO Standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
- b) Comma ( , ) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point ( . ) as the decimal marker.

In the adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
ISO 3548 : 1978 <sup>1)</sup> Plain bearings — Thin-walled half bearings — Dimensions, tolerances and methods of checking	IS 4774 ( Part 1 ) : 1988 Thin-walled half bearing : Part 1 Plain bearing ( <i>first revision</i> )	Technically Equivalent
ISO 6864 : 1984 Plain bearings — Thin-walled flanged half bearings — Dimensions, tolerances and methods of checking	IS 4774 ( Part 2 ) : 1998 Thin-walled half bearing : Part 2 Flanged bearings ( <i>first revision</i> )	do

<sup>1)</sup> ISO 3548 has been revised and 1999 version incorporates the requirement of ISO 6864 also.

## Indian Standard

# PLAIN BEARINGS — THIN-WALLED HALF-BEARINGS — CHECKING OF PERIPHERAL LENGTH

(First Revision)

## 1 Scope

This International Standard specifies methods of checking the measuring equipment and gauging tools necessary for measuring the peripheral length (or nip or crush) of thin-walled half-bearings.

Thin-walled half-bearings are flexible and, in the free condition, do not conform to a cylindrical profile. This is one reason why the peripheral length of the half-bearings can only be measured under a constraining load by use of specialized measuring equipment.

Measuring equipment different from that illustrated in this International Standard can be used, providing the measuring accuracy of the equipment is consistent with the specifications given in clause 17.

This International Standard does not include measurement of the joint face taper.

It applies to thin-walled half-bearings, the specifications of which are given in ISO 3548 and ISO 6864.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3548:1978, *Plain bearings — Thin-walled half bearings — Dimensions, tolerances and methods of checking*.

ISO 6864:1984, *Plain bearings — Thin-walled flanged half bearings — Dimensions, tolerances and methods of checking*.

## 3 Definitions

For the purposes of this International Standard, the following definitions apply.

**3.1 peripheral length:** The circumferential length which runs from one joint face to the other.

**3.2 nip; crush:** The value,  $a$ , by which a half-bearing fitted in a checking block of bore diameter  $d_{cb}$  under a predetermined checking load  $F$  exceeds the defined peripheral length of the checking block bore (see figure 1).

NOTE 1 In practice, the datum serves as a basis for measuring  $a$  (see figure 2).

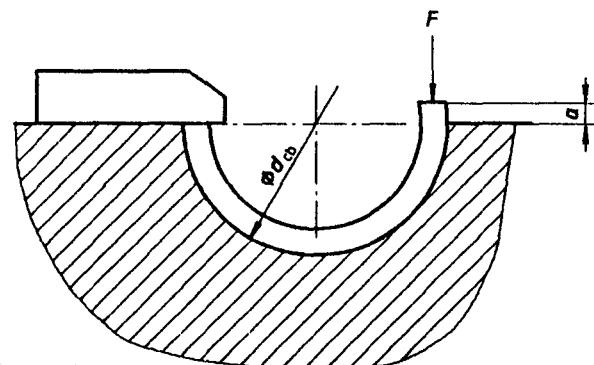


Figure 1 — Nip,  $a$

**3.3 repeatability:** The closeness of agreement between successive results obtained with the same method on the same test piece, under the same conditions (same operator, same measuring equipment, same checking place and time intervals).

NOTE 2 Repeatability is assessed from the standard deviation of repeatability  $\sigma_A$ . See annex E.

**3.4 reproducibility:** The closeness of agreement between individual results obtained with the same method on the same test piece but under different conditions (identical or different operator, measuring equipment, checking place and times).

NOTE 3 For the purposes of this International Standard, reproducibility is the difference between the two averages obtained from two sets of measuring equipment. See annex E.

**3.5 comparability:** The accuracy in the case of operators working in different checking places at different periods and each of them achieving individual results, one using method A and the other method B, on the same half-bearing in different checking blocks.

NOTE 4 Comparability is assessed from the difference between the two averages obtained from the two methods. See annex E.

#### 4 Symbols

NOTE 5 The characteristic subscripts are as follows:

bs: bearing to be checked

cb: checking block

cbm: master checking block

cbs: series checking block

cs: comparison shell

M: measured

ms: master shell

th: theoretical

$a$  or  $a_1 + a_2$  nip, in millimetres

$B$  width of the half-bearing without flange, in millimetres

$B_1$  checking block width (construction for flanged half-bearings), in millimetres

$B_2$  checking block width, in millimetres

$B_3$  checking block width (construction for half-bearings without flange), in millimetres

$B_{ms}$  master shell width, in millimetres

$d_{cb}$  diameter of the checking block bore, in millimetres<sup>1)</sup>

$D_{bs}$	outside diameter of the half-bearing to be checked, in millimetres
$D_{ms}$	outside diameter of the master shell, in millimetres <sup>1)</sup>
$E$	Young's modulus, in newtons per square metre
$f$	coefficient of friction in calculation of deflection under load
$F = F_1 = F_2$	checking load, in newtons
$F_{cor}$	correction factor, in millimetres <sup>1)</sup>
$h$	fillet radius between back and flange on flanged half-bearing, in millimetres
$H_{cb}$	distance from the bottom of the checking block bore to the datum plane, in millimetres <sup>1)</sup>
$\Delta H_{cb}$	elastic deformation of the height of the checking block under load, in millimetres
$K_1$	checking block chamfer (construction for half-bearings without flange), in millimetres
$K_2$	checking block chamfer (construction for flanged half-bearings), in millimetres
$l$	peripheral length, in millimetres <sup>1)</sup>
$\Delta l$	deviation of the actual peripheral length of the checking block, in millimetres
$p_E$	elastic depression of the toe piece, in millimetres
$R_a$	surface roughness, in microns
$s_{cs}$	wall thickness of the comparison shell, in millimetres
$s_{ms}$	wall thickness of the master shell, in millimetres
$s_{tot}$	total wall thickness of the half-bearing, in millimetres
$u$	uncertainty of measurement
$w$	width of the toe piece contact area, in millimetres
$z$	distance between flanges of the flanged half-bearing, in millimetres

1) The symbol may be followed by a subscript defining the gauging tool to which the symbol is applied and/or by a subscript indicating an effective measured value or a theoretical value.

$\delta$  empirical correction to compensate for the difference in elastic deflections under load between method A and method B, in millimetres

$\tilde{\delta}$  correction estimated by calculation

$\sigma$  standard deviation

## 5 Purpose of checking

It is necessary to keep to within the nip tolerances of ISO 3548 and ISO 6864 in order to guarantee the designated mounting compression (interference fit) for the half-bearings in the housing bore.

## 6 Checking methods

### 6.1 Method A

The checking load,  $F$ , is directly applied via the measuring head with a pivoting toe piece to one

joint face of the half-bearing whilst the other joint face is in contact with a fixed stop (see figure 2).

### 6.2 Method B

The checking loads  $F_1$  and  $F_2$  are applied via the measuring head and two toe pieces to both joint faces of the half-bearing (see figure 3).

**NOTE 6** In the case of method A, the fixed stop exerts the required counter-force which, in the case of method B, is applied directly by the measuring equipment via two toe pieces.

#### EXAMPLE

Method A  $F = 6\,000\text{ N}$

Method B  $\left\{ \begin{array}{l} F_1 = 6\,000\text{ N} \\ F_2 = 6\,000\text{ N} \end{array} \right.$

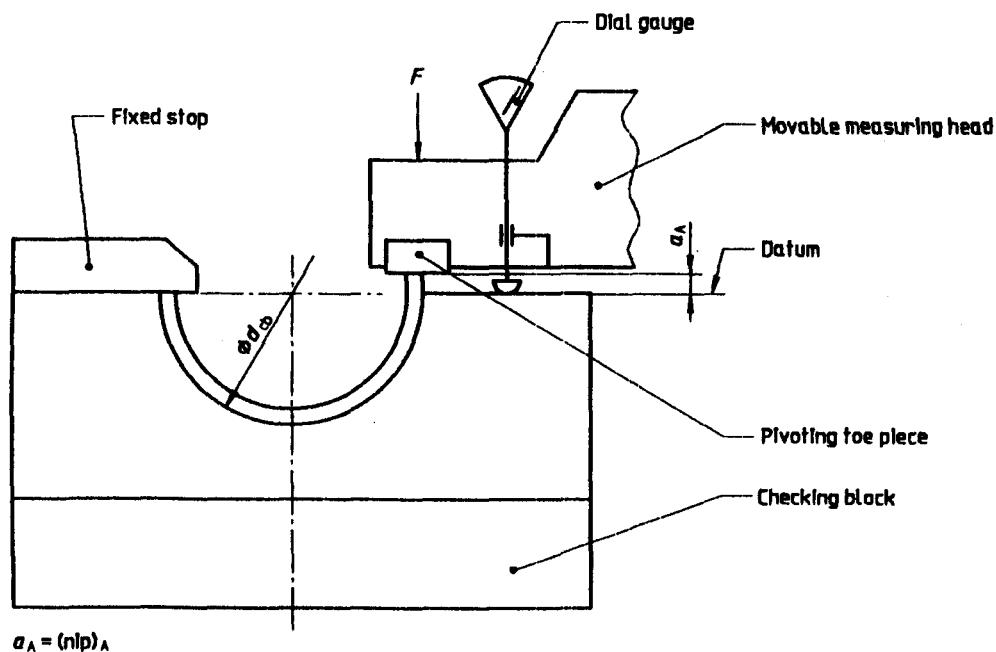
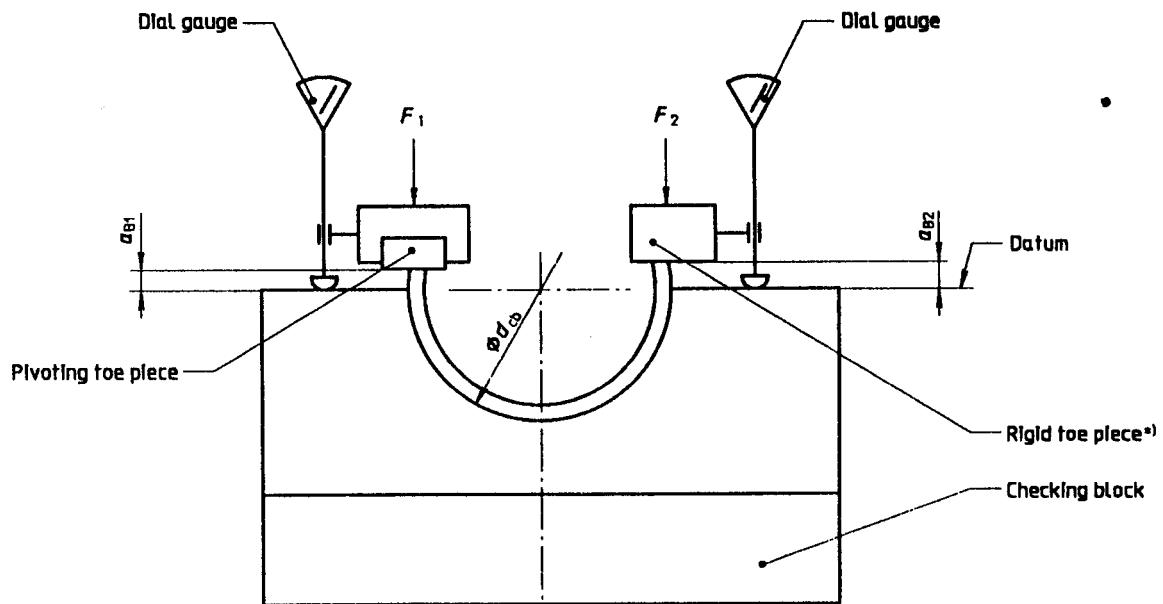


Figure 2 — Principle of method A



$$a_B = a_{B1} + a_{B2} = (nlp)_B$$

\*) Bearings may also be checked using two pivoting toe pieces.

Figure 3 — Principle of method B

## 7 Choice and designation of checking method

### 7.1 Choice of checking method

Recommendations for choosing either method A or method B, based on the dimensions of the half-bearings to be checked, are given in table 1.

However, any size of bearing may be tested by either method by agreement between the manufacturer and user. In that case, a correction  $\delta$  should be applied to compensate for the difference in deflections at joint face(s) under load between method A and method B, and be such that

$$a_A = a_{B1} + a_{B2} + \delta$$

The value of  $\delta$  shall be determined empirically by actual measurements obtained on the two different types of equipment used. Since the detailed design of the checking feature will vary between different manufacturers, the value of  $\delta$  established by one manufacturer cannot be transferred to another, who shall determine it separately. See example in annex E.

For general guidance, the value of  $\delta$  may be derived from the formula used in the mathematical analysis of belt friction, which gives

$$\delta = \frac{d_{cb,M}F}{s_{ms}B_{ms}} \times \frac{1}{2f} (1 + e^{-f\pi} - 2e^{-f\pi/2})$$

With a value of the friction coefficient  $f = 0,15$ , the formula becomes

$$\tilde{\delta} = 7 \times 10^{-7} \times \frac{d_{cb,M}F}{s_{ms}B_{ms}}$$

(See also 16.5.)

Table 1

$D_{bs}$ mm	Recommended checking method
$D_{bs} \leq 200$	A, B
$200 < D_{bs} \leq 500$	B

### 7.2 Designation of checking method

Example of the designation of method B for checking thin-walled half-bearings with an outside diameter,  $D_{bs}$ , of 340 mm:

Method ISO 6524-B-340

## 8 Measuring equipment

Figures 4 and 5 show typical measuring equipment for measuring the nip (crush) by method A and by method B, respectively.

NOTE 7 Figures 4 and 5 show hydraulically operated equipment. Pneumatically or mechanically operated equipment may also be used.

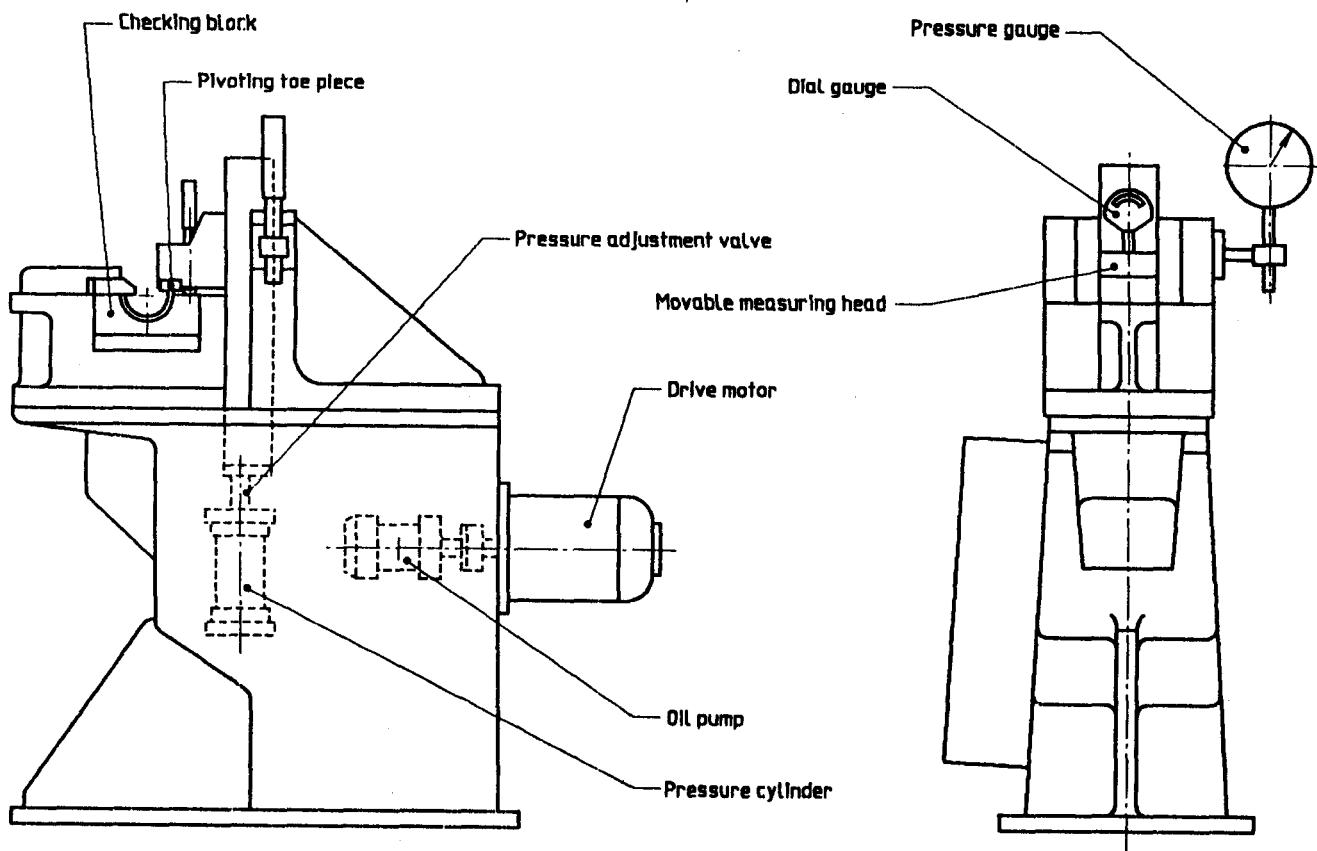
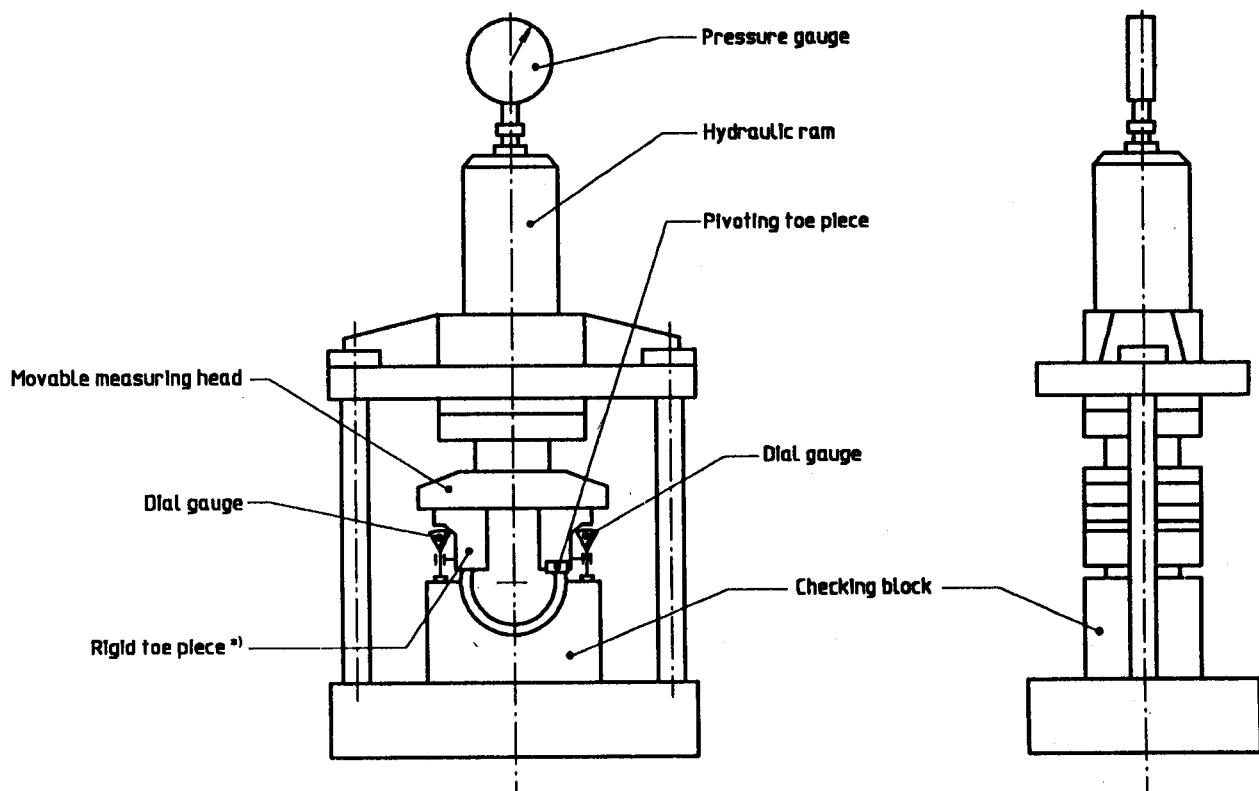


Figure 4 — Typical measuring equipment with one column, for method A



<sup>a)</sup> Bearings may also be checked using two pivoting toe pieces.

Figure 5 — Typical measuring equipment with two columns, for method B

## 9 Measuring equipment requirements

The most important factors affecting the accuracy of the measuring equipment (and hence the measured nip value) are given below.

### 9.1 Tolerance on checking load setting

The permissible tolerances are given in table 2.

Table 2

$F$ N	Tolerance on $F$ %
$F \leq 2\ 000$	$\pm 1,25$
$2\ 000 < F \leq 5\ 000$	$\pm 1$
$5\ 000 < F \leq 10\ 000$	$\pm 0,75$
$10\ 000 < F \leq 50\ 000$	$\pm 0,5$
$50\ 000 < F$	$\pm 0,25$

### 9.2 Speed of approach of measuring head

The checking load,  $F$ , shall be applied to the joint face(s) of the half-bearing so that shock load will not occur. The speed of approach shall be 10 mm/s  $\pm$  2 mm/s.

For devices in which the speed of approach cannot be altered, the load shall be applied, released and applied a second time before the measurement is made.

### 9.3 Construction of measuring head

The measuring head shall be so constructed that it is accurately guided and moves normal to the datum of the checking block. The deviation from parallelism between the toe piece(s) in the measuring head and the supporting plane of the checking block shall not exceed 0,04 mm per 100 mm in a radial direction.

#### 9.4 Accuracy of the measuring plane of the toe pieces

Specifications on the accuracy of the measuring plane of the toe pieces are given in table 3.

**Table 3**  
Dimensions and tolerances in millimetres  
Surface roughness in microns

$D_{bs}$	Surface roughness $R_s$	Tolerance on flatness
$D_{bs} \leq 160$	0,2	0,001 5
$160 < D_{bs} \leq 340$	0,4	0,003
$340 < D_{bs} \leq 500$		0,004

#### 9.5 Accuracy of the dial gauge

Uncertainty of measurement  $u \leq 1,2 \mu\text{m} (\pm 2\sigma)$  with  $\sigma = 0,3 \mu\text{m}$

### 10 Gauging tools for establishing the datum

The following equipment can be used for carrying out measurements:

- a master checking block (for reference measurements) (see clause 11),
- a series checking block (for series control in production) (see clause 11), or
- a master shell or comparison shell (for series control in production) (see clause 12).

It can be used in three ways (as indicated in 10.1, 10.2 and 10.3) to establish the appropriate datum for setting the dial gauge.

#### 10.1 Master checking block (used alone)

The master checking block is the comparison basis for the other checking blocks used for series control.

#### 10.2 Series checking block used alone

The peripheral length of the bore of this type of checking block is determined by comparison with the master checking block.

It is applied in series control without using a master shell or a comparison shell.

#### 10.3 Series checking block with master shell

The peripheral length of the checking block bore is determined by the master shell or comparison shell, the peripheral length of which was determined in the master checking block.

This combination of gauging tools is applied in series control.

NOTE 8 For series control, a checking block may also be used with a checking master, but this combination of gauging tools is not within the scope of this International Standard.

### 11 Checking block requirements

A typical checking block is shown in figure 6. The gauging part has a bore diameter  $d_{cb}$  and height  $H_{cb}$  and holds the half-bearings to be checked.

The checking block should preferably be of hardened steel and of rigid construction so that the requirements of clause 16 are met when the half-bearing is tested under load.

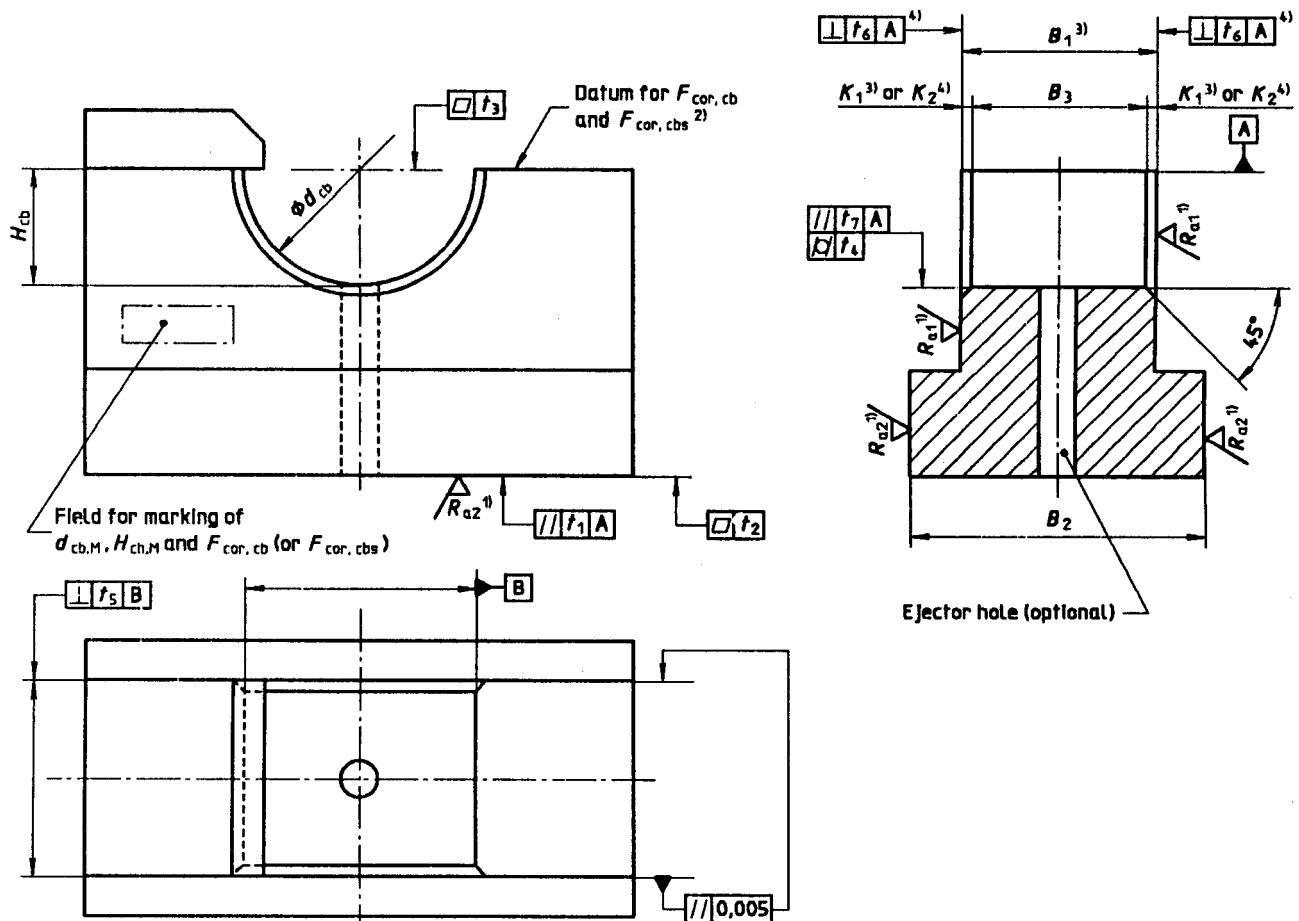
The bore of the checking block shall not be chromium plated.

Recesses shall be cut into the checking block to accommodate the nick in the half-bearings. They shall be 1 mm wider and deeper and 1,5 mm longer than the locating nicks in the half-bearings.

#### 11.1 Reference tooling: Master checking block

##### 11.1.1 Manufacturing limits

Manufacturing limits and specifications for the master checking block are given in table 4.



- 1) It is recommended that the values given in tables 5 and 6 be observed.
- 2) See 13.1 and 13.2.1.
- 3) Construction for half-bearing without flange :  
 $B_1$  may correspond to  $B_2$  or it may be adjusted to the width of the half-bearing, i.e. to  $B_{\max} + 1,2$  mm with  $K_{1\max} = 0,4$  mm
- 4) Construction for flanged half-bearing :  
 $B_1$ , see table 5  
 $K_2 = h_{\max} + 0,5$  mm

Figure 6 — Checking block

Table 4

Dimensions and tolerances in millimetres  
Surface roughness in microns

Outside diameter $D_{bs}$	Tolerance on $d_{cbm}$	Surface roughness of checking block bore $R_a$	Tolerance on $H_{cbm}$	Surface roughness of the datum $R_a$
$D_{bs} \leq 75$	$+0.003$ 0	0,2	$+0.003$ 0	0,3
$75 < D_{bs} \leq 110$	$+0.004$ 0		$+0.0035$ 0	
$110 < D_{bs} \leq 160$	$+0.005$ 0		$+0.004$ 0	
$160 < D_{bs} \leq 250$	$+0.006$ 0	0,4	$+0.0045$ 0	0,6
$250 < D_{bs} \leq 340$	$+0.0075$ 0	0,6	$+0.005$ 0	1
$340 < D_{bs} \leq 500$	$+0.01$ 0		$+0.006$ 0	

#### 11.1.1.1 Tolerances of form and orientation

It is the responsibility of the manufacturer of the master checking block to achieve high quality regarding tolerances of form and orientation, the values of which are given in tables 5 and 6.

#### 11.1.1.2 Surface roughnesses $R_{a1}$ and $R_{a2}$

See tables 5 and 6.

#### 11.1.1.3 Specifications for $B_1$ , $B_2$ and $B_3$

See tables 5 and 6.

#### 11.1.2 Measuring accuracy of equipment used for establishing $d_{cbm,M}$ and $H_{cbm,M}$

Determination of  $d_{cbm,M}$  and  $H_{cbm,M}$  shall be carried out using measuring equipment with a tolerance of

$\pm 0.001$  mm, for  $d_{cbm} \leq 160$  mm

$\pm 0.002$  mm, for  $d_{cbm} > 160$  mm

These values are necessary for calculating the correction factor  $F_{cor,cbm}$  (see 13.1), which is based on the peripheral length, determined from the formula:

$$l_{cbm,M} = d_{cbm,M} \times \frac{\pi}{2} + 2 \left( H_{cbm,M} - \frac{d_{cbm,M}}{2} \right)$$

#### 11.1.3 Permissible wearing limit

The tolerance specified in 11.1.1 for the master checking block shall not be exceeded through wear. If wear occurs within the specified tolerance range, then it will be necessary to change the correction factor.

### 11.2 Series gauging tools

#### 11.2.1 Series checking block used alone

Since the peripheral length of this checking block bore is determined by comparison with the master checking block (11.1), larger tolerances for  $d_{cbs}$  and  $H_{cbs}$  are acceptable.

##### 11.2.1.1 Manufacturing limits

Manufacturing limits and specifications for the series checking block are given in tables 7 to 9.

##### 11.2.1.2 Correction factor, $F_{cor,cbs}$

See 13.2.1.

Table 5

Dimensions and tolerances in millimetres  
Surface roughness in microns

$D_{bs}$	Bearing without flange $B_3 \text{ min}$	Flanged bearing		Surface roughness $R_{a1}$	Tolerances of form and orientation					
		$B_1 \text{ min}$	$B_1 \text{ max}$		$t_1$	$t_2$	$t_3$	$t_4$	$t_5$	$t_6$
$D_{bs} \leq 75$	$B_{\text{max}} + 0,4$	$z_{\text{min}} - 0,1$	$z_{\text{min}} - 0,05$	1,2	0,002	0,002	0,002	0,002	0,002	0,005
$75 < D_{bs} \leq 110$					0,005	0,005	0,005	0,004	0,003	0,006
$110 < D_{bs} \leq 160$				1,6	0,007	0,007				
$160 < D_{bs} \leq 250$										
$250 < D_{bs} \leq 340$										
$340 < D_{bs} \leq 500$										

Table 6

Dimensions and tolerances in millimetres  
Surface roughness in microns

$B$	$B_2$ $\begin{smallmatrix} +2 \\ 0 \end{smallmatrix}$	Surface roughness $R_{a2}$	Tolerance on parallelism $t_7$	
			$t_7$	$t_7$
$B \leq 55$	60	1,2	0,002	
$55 < B \leq 80$	85		0,003	
$80 < B$	$B + 5$		0,004	

Table 7

Dimensions and tolerances in millimetres  
Surface roughness in microns

$D_{bs}$	Tolerance on $d_{cbs}$	Surface roughness of checking block bore $R_a$	Tolerance on $H_{cbs}$		Surface roughness of the datum $R_a$
			$t_8$	$t_9$	
$D_{bs} \leq 75$	$\begin{smallmatrix} +0,008 \\ 0 \end{smallmatrix}$	0,2	$\begin{smallmatrix} +0,008 \\ 0 \end{smallmatrix}$	$\begin{smallmatrix} +0,009 \\ 0 \end{smallmatrix}$	0,3
$75 < D_{bs} \leq 110$	$\begin{smallmatrix} +0,01 \\ 0 \end{smallmatrix}$		$\begin{smallmatrix} +0,009 \\ 0 \end{smallmatrix}$		
$110 < D_{bs} \leq 160$	$\begin{smallmatrix} +0,012 \\ 0 \end{smallmatrix}$		$\begin{smallmatrix} +0,01 \\ 0 \end{smallmatrix}$		
$160 < D_{bs} \leq 250$	$\begin{smallmatrix} +0,014 \\ 0 \end{smallmatrix}$	0,4	$\begin{smallmatrix} +0,01 \\ 0 \end{smallmatrix}$	$\begin{smallmatrix} +0,011 \\ 0 \end{smallmatrix}$	0,6
$250 < D_{bs} \leq 340$	$\begin{smallmatrix} +0,017 \\ 0 \end{smallmatrix}$	0,6	$\begin{smallmatrix} +0,011 \\ 0 \end{smallmatrix}$	$\begin{smallmatrix} +0,012 \\ 0 \end{smallmatrix}$	1
$340 < D_{bs} \leq 500$	$\begin{smallmatrix} +0,022 \\ 0 \end{smallmatrix}$		$\begin{smallmatrix} +0,012 \\ 0 \end{smallmatrix}$		

Table 8

Dimensions and tolerances in millimetres  
Surface roughness in microns

$D_{bs}$	Bearing without flange $B_3 \text{ min}$	Flanged bearing		$R_{a1}$	Tolerances of form and orientation					
		$B_1 \text{ min}$	$B_1 \text{ max}$		$t_1$	$t_2$	$t_3$	$t_4$	$t_5$	$t_6$
$D_{bs} \leq 75$	$R_{\text{max}} + 0,4$	$z_{\text{min}} - 0,1$	$z_{\text{min}} - 0,05$	1,2	0,004	0,004	0,004	0,004	0,004	0,01
$75 < D_{bs} \leq 110$					0,01	0,01	0,01	0,008	0,006	0,012
$110 < D_{bs} \leq 160$				1,6	0,014	0,014				
$160 < D_{bs} \leq 250$										
$250 < D_{bs} \leq 340$										
$340 < D_{bs} \leq 500$										

Table 9

Dimensions and tolerances in millimetres  
Surface roughness in microns

$B$	$B_2$ ${}^{+2}_{-0}$	Surface roughness $R_{a2}$	Tolerance on parallelism $t_7$
$B \leq 55$	60	1,2	0,004
$55 < B \leq 80$	85		0,006
$80 < B$	$B + 5$		0,008

#### 11.2.1.3 Permissible wearing limit

The limit of permissible wear of the series checking block is reached when the difference between the correction factor in original and worn conditions is equal to the values stated in table 10.

Table 10

$d_{cbs}$ mm	Permissible difference $ F_{\text{cor,cbs,new}} - F_{\text{cor,cbs,worn}} $ mm
$d_{cbs} \leq 75$	0,012
$75 < d_{cbs} \leq 110$	0,016
$110 < d_{cbs} \leq 160$	0,02
$160 < d_{cbs} \leq 250$	0,024
$250 < d_{cbs} \leq 340$	0,03
$340 < d_{cbs} \leq 500$	0,04

#### 11.2.2 Series checking block with master shell or with comparison shell

##### 11.2.2.1 Manufacturing limits

Manufacturing limits and specifications for the series checking block are given in tables 7 to 9.

##### 11.2.2.2 Correction factor

See 13.2.2.

##### 11.2.2.3 Permissible wearing limit

The limit of permissible wear of the series checking block is reached when the difference between the correction factor in original and worn conditions is equal to the values stated in table 10.

## 12 Master shell and comparison shell requirements

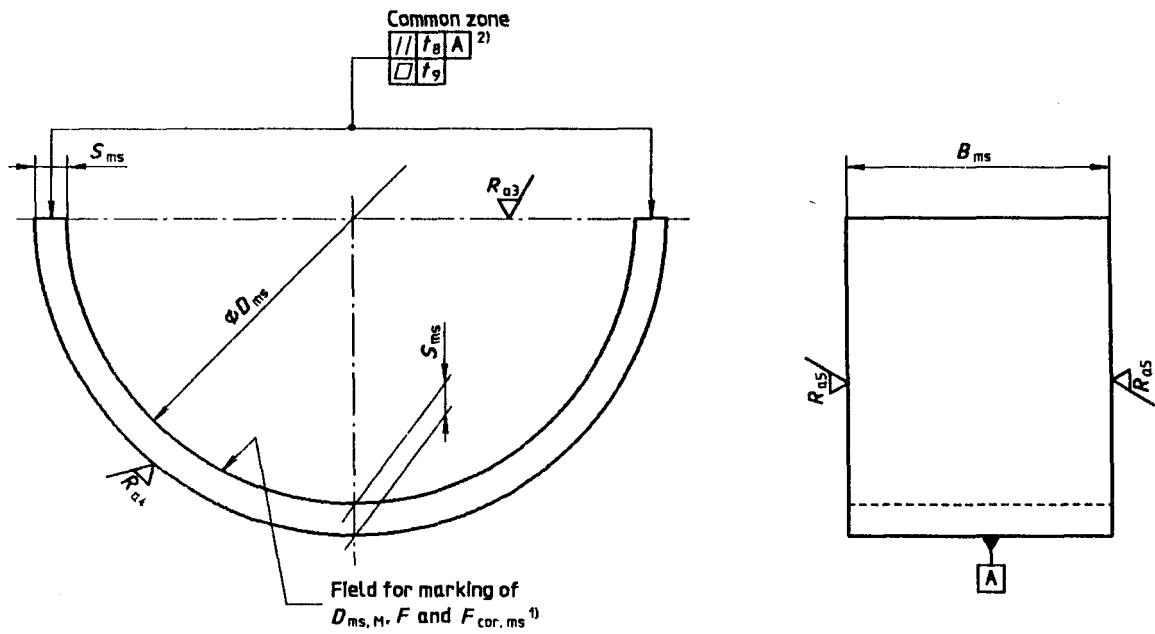
### 12.1 Master shell requirements

The basic dimensions of the master shell shall correspond to those of the half-bearings to be checked (see figure 7). The master shell shall have similar behaviour to the half-bearing when it is fitted into the checking block.

NOTE 9 This cylindrical master shell is also used for checking flanged half-bearings.

Master shells shall be made from hardened steel (58 HRC min.). Normally master shells are only used up to 200 mm diameter.

In order that a single master may be used for a group of parts down to 1 mm undersize,  $s_{ms}$  shall be equal to the total wall thickness  $s_{tot}$  of the standard half-bearing to be checked plus 0,125 mm.



$$s_{ms} = s_{tot} + 0,125 \text{ mm}$$

1) See 13.2.3.

2) Tolerances on parallelism  $f_8$  and flatness  $f_9$  apply when the master shell is fitted in the checking block (zero free spread) under the checking load.

Figure 7 — Master shell

The master shell shall be of similar geometry to that of the bearing being checked. Masters of a different geometry from that of the shell shall not be used since friction and elastic deformation will differ significantly from those of the bearing. See figure 8.

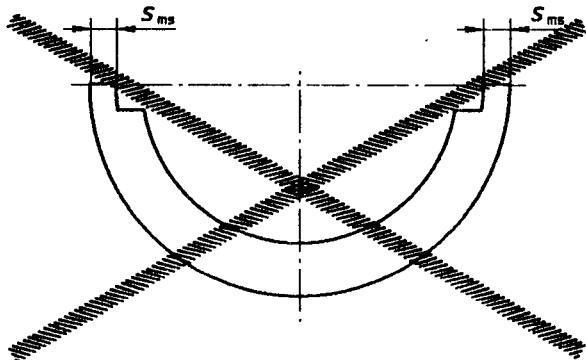


Figure 8 — Stepped master shell not suitable for checking bearings of uniform wall thickness

### 12.1.1 Manufacturing limits

Manufacturing limits and specifications for the master shell are given in tables 11 and 12.

### 12.1.2 Correction factor, $F_{\text{cor,ms}}$

See 13.2.3.

### 12.1.3 Permissible wearing limit

The limit of the permissible wear of the master shell is reached when the difference between the correction factor in original and worn conditions is equal to the values stated in table 13.

Table 11

Dimensions and tolerances in millimetres  
Surface roughness in microns

$D_{\text{ms}}$	Tolerance on $R_{\text{ms}}$	Tolerance on $s_{\text{ms}}$	Surface roughness	
			$R_{\text{a}3}$	$R_{\text{a}5}$
$D_{\text{ms}} \leq 160$	$\pm 0,1$	$\pm 0,015$	0,2	2
$160 < D_{\text{ms}} \leq 200$	$\pm 0,15$	$\pm 0,02$		

Table 12

Dimensions and tolerances in millimetres  
Surface roughness in microns

$D_{\text{ms}}$	Surface roughness $R_{\text{a}4}$	Tolerance on parallelism $t_8$	Spread	Tolerance on flatness $t_9$
				$t_9$
$D_{\text{ms}} \leq 160$	0,3	0,004	Within the limits of the half-bearing to be checked	0,003
$160 < D_{\text{ms}} \leq 200$	0,5	0,006		

**Table 13**

$D_{ms}$ mm	Permissible difference $ F_{cor,ms,new} - F_{cor,ms,worn} $ mm
$D_{ms} \leq 160$	0,03
$160 < D_{ms} \leq 200$	0,035

## 12.2 Comparison shell requirements

For economic reasons, the nip of the half bearings may be determined using comparison shells rather than master shells.

Comparison shells shall be made from stainless steel or cold or hot worked tool steel. In special cases, a normal production bearing may also be used.

The relative manufacturing limits shall be agreed upon between manufacturer and customer.

## 13 Correction factors

### 13.1 Reference tooling: Master checking block correction factor, $F_{cor,cbm}$

The measured peripheral length of the master checking block bore,  $l_{cbm,M}$ , is given by the following equation (see 11.1.2):

$$l_{cbm,M} = d_{cbm,M} \times \frac{\pi}{2} + 2 \left( H_{cbm,M} - \frac{d_{cbm,M}}{2} \right)$$

The theoretical peripheral length of the master checking block bore,  $l_{cbm,th}$ , is given by the following equation (see 11.1.2):

$$l_{cbm,th} = d_{cbm,th} \times \frac{\pi}{2}$$

The correction factor of the master checking block is therefore

$$F_{cor,cbm} = l_{cbm,M} - l_{cbm,th}$$

The other factors to be taken into consideration, their determination and calculation are given in annex A (for method A) and annex B (for method B).

The basis for the correction factor  $F_{cor,cbm}$  is the datum of the master checking block (see figures 2 and 3).

### 13.2 Series control tooling

#### 13.2.1 Correction factor for series checking block used alone, $F_{cor,cbs}$

The correction factor  $F_{cor,cbs}$  is the difference between the nip of a half-bearing measured in a master checking block ( $a_{cbm}$ ) and in a series checking block ( $a_{cbs}$ ) under equal checking conditions (see annex C):

$$F_{cor,cbs} = a_{cbm,M} - a_{cbs,M}$$

When setting the dial gauge, the correction factor  $F_{cor,cbs}$  of the series checking block only shall be taken into consideration.

The basis for the correction factor  $F_{cor,cbs}$  is the datum of the series checking block.

#### 13.2.2 Correction factor for series checking block with master shell

The correction factor  $F_{cor,cbs}$  of the series checking block should not be taken into consideration when carrying out measurements; it is only to check the wearing limit of the series checking block.

When setting the dial gauge, the correction factor  $F_{cor,ms}$  of the master shell only (see 13.2.3) shall be taken into consideration.

#### 13.2.3 Master shell correction factor, $F_{cor,ms}$

The correction factor  $F_{cor,ms}$  is the amount by which a master shell fitted in a master checking block bore, under a predetermined checking load, deviates from the theoretical peripheral length of the master checking block bore.

For determining the correction factor  $F_{cor,ms}$ , see annex D.

When setting the dial gauge, the correction factor of the master shell ( $F_{cor,ms}$ ) shall be taken into consideration.

The basis for the correction factor  $F_{cor,ms}$  is the joint face of the master shell, the peripheral length of which shall be measured in a master checking block, in accordance with 13.1.

**NOTE 10** The correction factor  $F_{cor,ms}$  is equal to zero when the master shell is exactly adjusted to the peripheral length of the master checking block bore, the bore diameter  $d_{cbm}$  of which corresponds to the outside diameter  $D_{bs}$  of the half-bearing to be checked.

#### 13.2.4 Comparison shell correction factor, $F_{cor,cs}$

The correction factor  $F_{cor,cs}$  is the amount by which a comparison shell fitted in a master checking block bore, under a predetermined checking load, deviates

ates from the theoretical peripheral length of the master checking block bore.

For determining the correction factor  $F_{\text{cor,cs}}$ , see annex D.

When setting the dial gauge, the correction factor of the comparison shell  $F_{\text{cor,cs}}$  shall be taken into consideration.

The basis for the correction factor  $F_{\text{cor,cs}}$  is the joint face of the comparison shell, the peripheral length of which shall be measured in a master checking block, in accordance with 13.1.

**NOTE 11** The correction factor  $F_{\text{cor,cs}}$  is equal to zero when the comparison shell is exactly adjusted to the peripheral length of the master checking block bore, the bore diameter  $d_{\text{cbm}}$  of which corresponds to the outside diameter  $D_{\text{bs}}$  of the half-bearing to be checked.

### 13.3 Marking

The correction factor calculated shall be engraved on each of the gauging tools.

### 13.4 Reference setting

In cases of dispute, the setting shall be made in accordance with the determined correction factor in a master checking block (see 13.1). The method shall be agreed between the manufacturer and customer.

## 14 Typical checking procedure

**14.1** Place the checking block in the measuring equipment, line it up and secure it against lateral movement.

**14.2** Set the checking load in accordance with specifications.

**14.3** Under the specified checking load, lower the pivoting toe piece (for method A) or the toe pieces (for method B) vertically onto the datum of the checking block or onto the joint face of the master shell, or of the comparison shell.

In the case of method A, adjust the dial gauge to the full value of the correction factor engraved on either the checking block ( $F_{\text{cor,cb}}$  or  $F_{\text{cor,cbs}}$ ), the master shell ( $F_{\text{cor,ms}}$ ) or the comparison shell ( $F_{\text{cor,cs}}$ ).

In the case of method B, adjust both dial gauges to one-half of the correction factor (see figure 3).

**14.4** Place the half-bearing to be checked (see also clause 15) in the checking block and apply the checking load via the measuring head.

**14.5** Determine the nip variation of the half-bearing, in the case of method A, by reading off the dial gauge directly or, in the case of method B, by adding the partial nip variations recorded on the two dial gauges.

**14.6** The measuring temperature shall be between 20 °C and 25 °C when using the master block, but series checking may take place at room temperature if both the measuring equipment and the half-bearings being checked are at the same temperature.

**14.7** When carrying out reference measurements, the value of the nip is the average of three measurements taken at a temperature of 20 °C.

## 15 Condition of the half-bearings to be checked

The joint and back faces of the half-bearing shall be free of foreign matter, grease and any damage, and shall be at the same temperature as the checking block being used.

## 16 Measuring errors

### 16.1 Errors due to the measuring equipment

These errors are due to

- an incorrect position of the checking block (longitudinal or transverse direction);
- the checking block being incorrectly fixed in the measuring equipment;
- an incorrect setting of the checking load;
- an excessive speed of approach of the load;
- the pivoting toe piece being too tight or having too much clearance;
- damage or wear of the toe piece(s).

### 16.2 Errors due to the checking block

These errors are due to

- the difference in temperature between the half-bearing and checking block;
- damage or wear of the checking block;
- the recess for locating nicks being too large;
- the locating nick fouling the notch in the checking block;

- the bore of the checking block being chromium plated;
- the fixed stop (for method A) not covering the total joint face of the bearing;
- the fixed stop (for method A) deflecting too much and/or being poorly attached;
- damage or wear of the fixed stop;
- the checking block width  $B_3$  being smaller than the bearing width in the case of bearings without flange;
- the checking block width  $B_1$  or  $B_3$  for flanged bearings being too large, so that bearings are in contact with the checking block at the fillet radius between back and flange ( $K_1$  or  $K_2$  incorrect).

### 16.3 Errors due to the correction factor

These errors are due to

- an incorrect reading-off when measuring  $d_{cb,M}$  and  $H_{cb,M}$ ;
- an error in calculating the correction factor.

### 16.4 Errors due to the half-bearing

These errors are due to

- grease, dirt or damage on the outside diameter or joint face;
- joint face taper being excessive.

### 16.5 Error due to the choice of checking method

An error may arise if the correction  $\delta$  is not considered when the half-bearing is tested by a method other than the method specified on the bearing drawing (see 7.1 and E.3).

## 17 Accuracy of methods used

This clause gives a statistical approach to evaluating the accuracy of the methods used by determining the repeatability and the reproducibility of the measurement results and by comparing results obtained with methods A and B.

### 17.1 Checking conditions

See table 14.

### 17.2 Limits

The values given in table 15 are a basis for interpreting the test results.

### 17.3 Calculation

Details of the methods of calculation and the interpretation of the test results of repeatability, reproducibility and comparability are given in annex E.

## 18 Specifications on bearing drawings

The following should be specified in the drawing, represented graphically or otherwise, for the measurement of the nip:

- a) the recommended checking method (A or B) (see clause 7);
- b) the checking load;
- c) the nip (crush);
- d) diameter  $d_{cb,th}$  and the distance from the bottom of the checking block to the datum plane,  $H_{cb,th}$ .

## 19 Specifications for the control of the checking means

19.1 The gauging tools shall be checked regularly, significant damage made good and any dimensional changes to the gauging tools engraved on them.

19.2 The measuring equipment shall be checked as to its accuracy, at specified time intervals (with regard to statistical methods).

Table 14

Datum	Repeatability	Reproducibility		Comparability
		Case 1 <sup>1)</sup>	Case 2 <sup>2)</sup>	
Half-bearings	S	S	S	S
Measuring equipment	S	S or I	I or S	D
Checking block	S	S	I or D	D
Operator	S	S or D	D	D
Checking place	S	S or D	D	D
Checking time	Short period	D	D	D

**Key**

S: Same = physically the same.

I: Identical = in accordance with this International Standard, made to the same design, drawings and specifications.

D: Different = in accordance with this International Standard but made to different designs, drawings and specifications.

1) The same half-bearings are checked in the same checking block with the same checking equipment, or with an identical one (in which the checking block can be mounted), by a single operator or different operators working in the same or in different places at different times.

2) The same half-bearings are checked in identical or in different checking blocks, with identical or different checking equipment by operators working in different places at different times.

Table 15

$D_{bs}$ mm	$\sigma_{AB}$ $\mu\text{m}$	Reproducibility		Comparability <sup>1)</sup> $ \bar{x}_A - \bar{x}_B $ max. $\mu\text{m}$
		Case 1 <sup>2)</sup> $ \bar{x}_1 - \bar{x}_2 $ max. $\mu\text{m}$	Case 2 <sup>3)</sup> $ \bar{x}_1 - \bar{x}_2 $ max. $\mu\text{m}$	
$D_{bs} \leq 75$	1,1	3	8	10
$75 < D_{bs} \leq 160$	1,4	4	9	14
$160 < D_{bs} \leq 340$	2,2	6	16	24
$340 < D_{bs} \leq 500$	2,8	8	18	30

1) In order to achieve these values, especially for thicker bearings, a good contact between the toe piece (fixed stop) and the bearing joint faces is of prime importance.

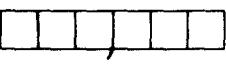
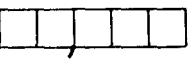
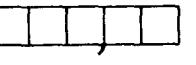
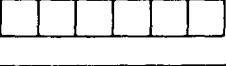
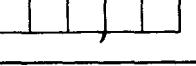
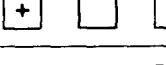
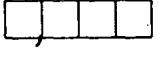
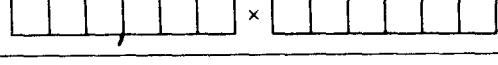
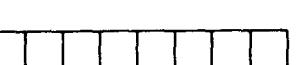
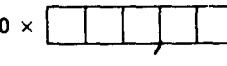
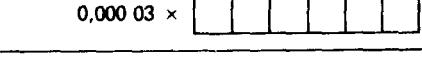
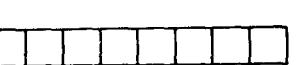
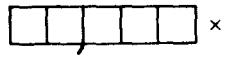
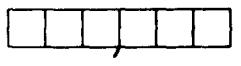
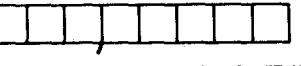
2) The same half-bearings are checked in the same checking block with the same checking equipment, or with an identical one (in which the checking block can be mounted), by a single operator or different operators working in the same or in different places at different times.

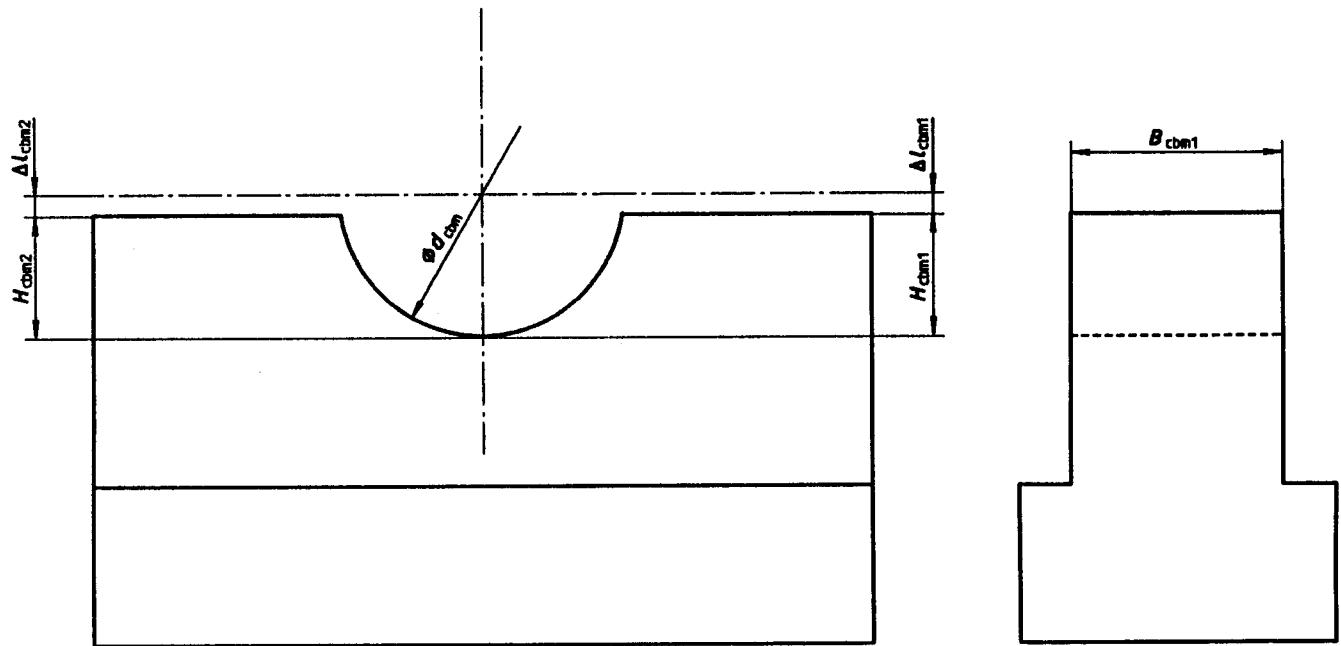
3) The same half-bearings are checked in identical or in different checking blocks, with identical or different checking equipment by operators working in different places at different times.

**Annex A**  
(normative)

**Determination of the correction factor of the master checking block — Method A**

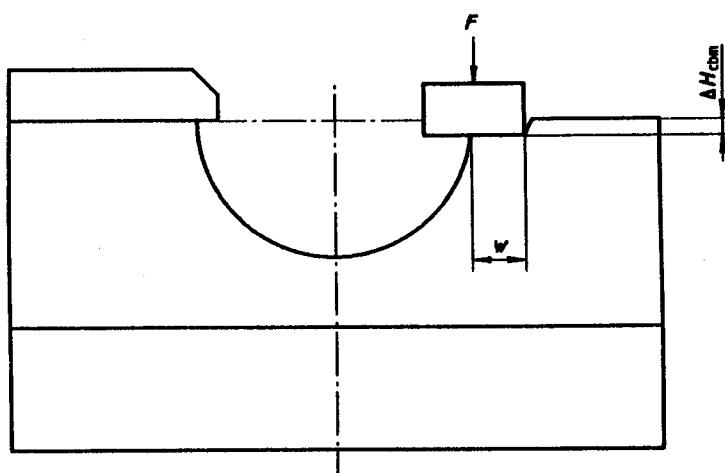
**A.1 Calculation form**

Firm	Number of drawing	Type of bearing
$d_{cbm, th} =$  mm	$s_{tot} =$  mm	$B_{max} =$  mm
$F =$  N	$B_{cbm1} \text{ or } B_{cbm3, min} =$  mm	
1 Actual peripheral length before correction (see figure A.1)		
$d_{cbm, M} \times \frac{\pi}{2} =$  $\times 1,570,8 =$  mm		
2 Deviations $\Delta l_{cbm1}$ and $\Delta l_{cbm2}$ (take signs into account, see note under figure A.1)		
$\Delta l_{cbm1} =$  mm		
$\Delta l_{cbm2} =$  mm		
$\Sigma \Delta l_{cbm} =$  mm  mm		
3 Elastic variation of $H_{cbm, th}$ (see figure A.2)		
$\Delta H_{cbm} = \frac{H_{cbm, th} F}{5 \times 10^5 \times w B_{cbm1}} =$  $\times$  mm		
$500,000 \times$ 		
4 Elastic depressions at the fixed stop and toe piece (see figure A.3)		
$p_{E1} + p_{E2} = \frac{0,000,03 F}{s_{tot} B} =$  $=$  mm		
		
5 Flexibility of the fixed stop under checking load $\Delta l_{cbm}$ (see figure A.4)		
 mm		
6 Measured peripheral length (after correction)		
$l_{cbm, M} = \Sigma (1 \text{ to } 5) =$  mm		
7 Theoretical peripheral length		
$l_{cbm, th} = d_{cbm, th} \times \frac{\pi}{2} =$  $\times 1,570,8 =$  mm		
8 Correction factor for master checking block		
$F_{cor, cbm} =$  mm  mm		
Determine steps 1, 2 and 5 by measurement.		



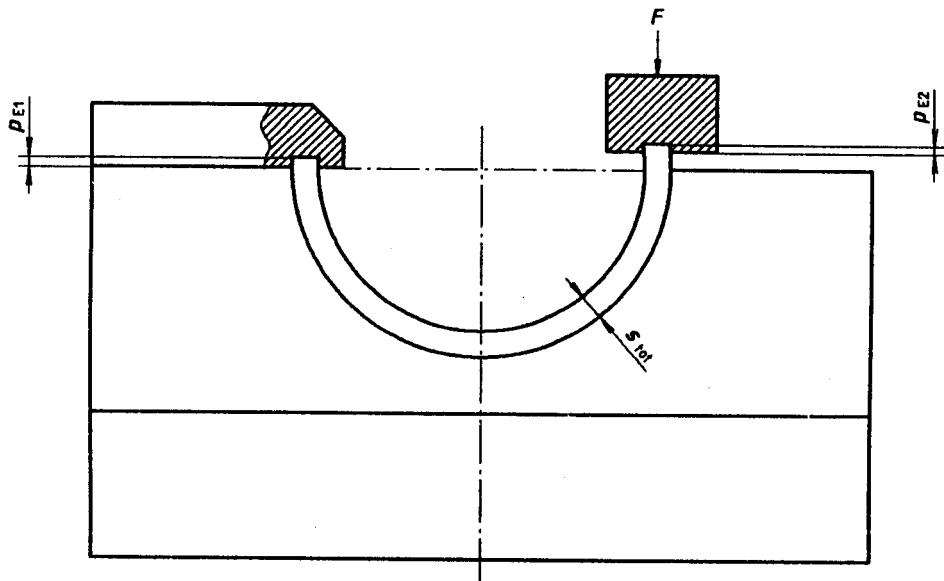
NOTE —  $\Delta l_{cbm1} = H_{cbm1,M} - \frac{d_{cbm,M}}{2}$  and  $\Delta l_{cbm2} = H_{cbm2,M} - \frac{d_{cbm,M}}{2}$

Figure A.1



NOTE —  $w$  is the width of the toe piece contact area, in millimetres.

Figure A.2



NOTE —  $p_{E1}$  and  $p_{E2}$  are negligible if the measuring planes of the toe piece and the fixed stop are coated with hard carbide.

Figure A.3

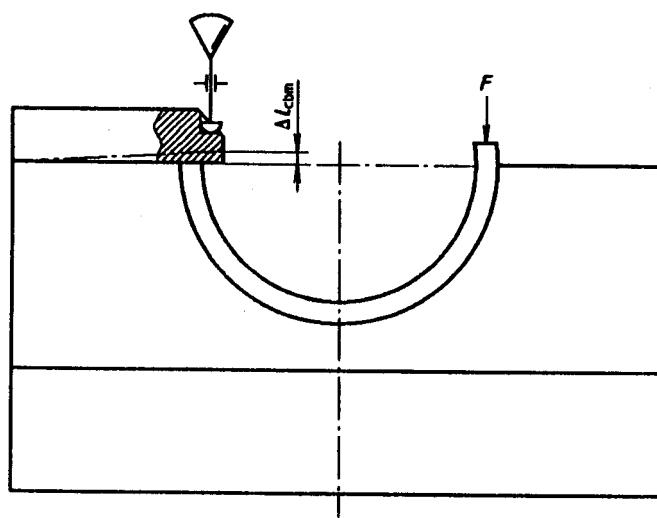


Figure A.4

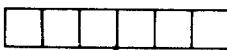
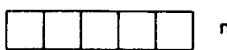
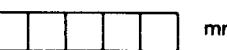
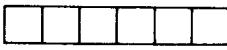
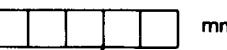
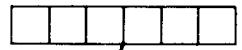
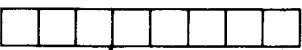
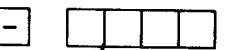
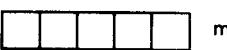
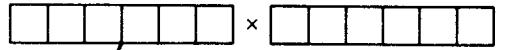
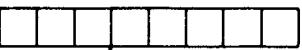
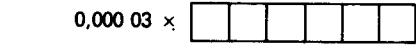
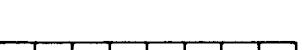
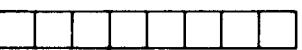
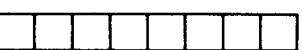
## A.2 Numerical example

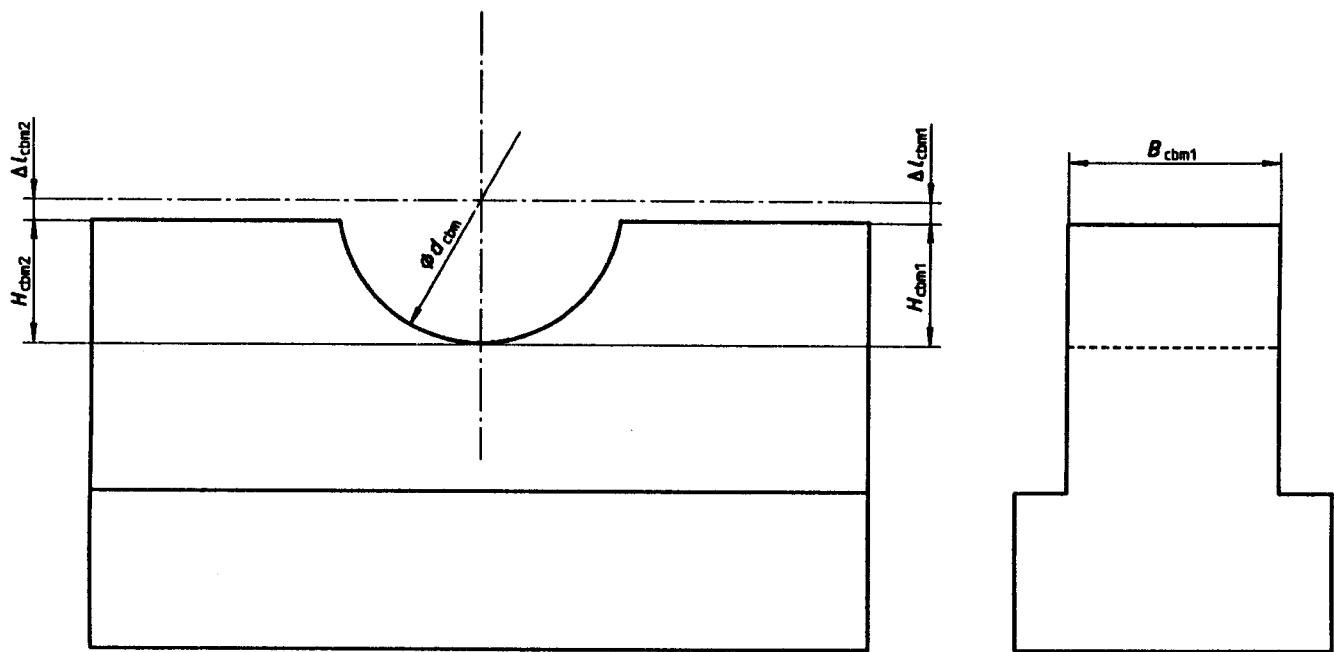
Firm	Number of drawing	Type of bearing
$d_{cbm, th} = \boxed{5} \boxed{4} \boxed{5} \boxed{2} \boxed{1}$ mm	$s_{tot} = \boxed{1} \boxed{9} \boxed{5} \boxed{0}$ mm	$B_{max} = \boxed{3} \boxed{5} \boxed{0} \boxed{0}$ mm
$F = \boxed{5} \boxed{8} \boxed{0} \boxed{0}$ N		$B_{cbm1} \text{ or } B_{cbm3, min} = \boxed{3} \boxed{5} \boxed{0} \boxed{0}$ mm
1 Actual peripheral length before correction (see figure A.1)		
$d_{cbm, M} \times \frac{\pi}{2} = \boxed{5} \boxed{4} \boxed{5} \boxed{2} \boxed{2}$	$\times 1,5708 = \longrightarrow$	$\boxed{8} \boxed{5} \boxed{6} \boxed{4} \boxed{2} \boxed{9}$ mm
2 Deviations $\Delta l_{cbm1}$ and $\Delta l_{cbm2}$ (take signs into account, see note under figure A.1)		
$\Delta l_{cbm1} = \boxed{-} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{1}$ mm		
$\Delta l_{cbm2} = \boxed{+} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{0}$ mm		
$\Sigma \Delta l_{cbm} = \boxed{-} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{1}$ mm	$\longrightarrow$	$\boxed{-} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{1} \boxed{0}$ mm
3 Elastic variation of $H_{cbm, th}$ (see figure A.2)		
$\Delta H_{cbm} = \frac{H_{cbm, th} F}{5 \times 10^5 \times w B_{cbm1}} = \frac{\boxed{2} \boxed{7} \boxed{2} \boxed{6} \boxed{0} \times \boxed{5} \boxed{8} \boxed{0} \boxed{0}}{500\,000 \times \boxed{1} \boxed{0} \times \boxed{3} \boxed{5} \boxed{0} \boxed{0}}$	$= \boxed{-}$	$\boxed{0} \boxed{0} \boxed{0} \boxed{0} \boxed{9}$ mm
4 Elastic depressions at the fixed stop and toe piece (see figure A.3)		
$p_{E1} + p_{E2} = \frac{0,000\,03 F}{s_{tot} B} = \frac{0,000\,03 \times \boxed{5} \boxed{8} \boxed{0} \boxed{0}}{\boxed{1} \boxed{9} \boxed{5} \boxed{0} \times \boxed{3} \boxed{5} \boxed{0} \boxed{0}}$	$= \boxed{+}$	$\boxed{0} \boxed{0} \boxed{0} \boxed{2} \boxed{5}$ mm
5 Flexibility of the fixed stop under checking load $\Delta l_{cbm}$ (see figure A.4)		
	$\boxed{+}$	$\boxed{0} \boxed{0} \boxed{0} \boxed{2}$ mm
6 Measured peripheral length (after correction)		
$l_{cbm, M} = \Sigma (1 \text{ to } 5) = \boxed{+}$		$\boxed{8} \boxed{5} \boxed{6} \boxed{4} \boxed{5} \boxed{5}$ mm
7 Theoretical peripheral length		
$l_{cbm, th} = d_{cbm, th} \times \frac{\pi}{2} = \boxed{5} \boxed{4} \boxed{5} \boxed{2} \boxed{1} \times 1,5708 = \longrightarrow$	$\boxed{-}$	$\boxed{8} \boxed{5} \boxed{6} \boxed{4} \boxed{1} \boxed{3}$ mm
8 Correction factor for master checking block		
$F_{cor, cbm} = \boxed{+} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{4}$ mm	$\longleftarrow$	$\boxed{+} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{4} \boxed{2}$ mm
Determine steps 1, 2 and 5 by measurement.		

**Annex B**  
(normative)

**Determination of the correction factor of the master checking block — Method B**

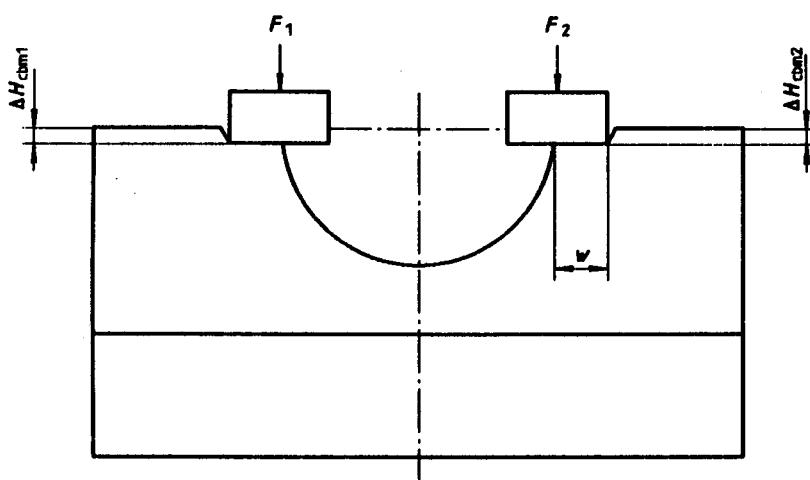
**B.1 Calculation form**

Firm	Number of drawing	Type of bearing
$d_{\text{cbm, th}} =$  mm	$s_{\text{tot}} =$  mm	$B_{\text{max}} =$  mm
$F =$  N	$B_{\text{cbm1}} \text{ or } B_{\text{cbm3, min}} =$  mm	
1 Actual peripheral length before correction (see figure B.1)		
$d_{\text{cbm, M}} \times \frac{\pi}{2} =$  mm	$\times 1,5708 =$  mm	
2 Deviations $\Delta l_{\text{cbm1}}$ and $\Delta l_{\text{cbm2}}$ (take signs into account, see note under figure B.1)		
$\Delta l_{\text{cbm1}} =$  mm	$\Delta l_{\text{cbm2}} =$  mm	
$\Sigma \Delta l_{\text{cbm}} =$  mm	$\rightarrow$	 mm
3 Elastic variation: $\Delta H_{\text{cbm}} = \Delta H_{\text{cbm1}} + \Delta H_{\text{cbm2}}$ (see figure B.2)		
$\Delta H_{\text{cbm}} = \frac{H_{\text{cbm, th}} F}{2,5 \times 10^5 \times w B_{\text{cbm1}}} =$  $\times$  mm	$=$   mm	
4 Elastic depressions at both toe pieces (see figure B.3)		
$p_{E1} + p_{E2} = \frac{0,00003 F}{s_{\text{tot}} B} =$  $\times$  mm	$=$   mm	
5 Measured peripheral length (after correction)		
$l_{\text{cbm, M}} = \Sigma (1 \text{ to } 4) =$   mm		
6 Theoretical peripheral length		
$l_{\text{cbm, th}} = d_{\text{cbm, th}} \times \frac{\pi}{2} =$  $\times 1,5708 =$  mm		
7 Correction factor for master checking block		
$F_{\text{cor, cbm}} =$  mm	$\rightarrow$	 mm
Determine steps 1 and 2 by measurement.		



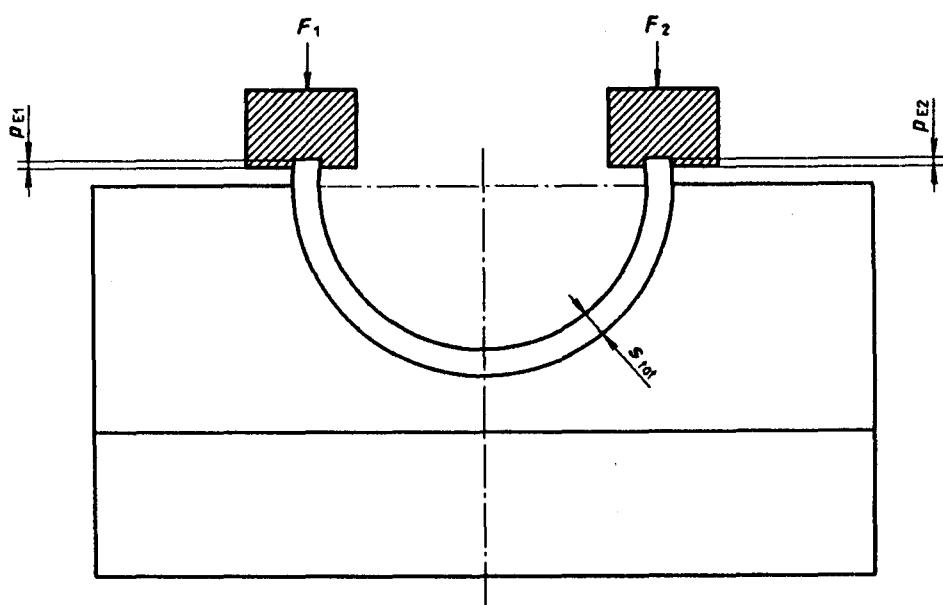
NOTE —  $\Delta l_{\text{cbm}1} = H_{\text{cbm1,M}} - \frac{d_{\text{cbm1,M}}}{2}$  and  $\Delta l_{\text{cbm}2} = H_{\text{cbm2,M}} - \frac{d_{\text{cbm2,M}}}{2}$

Figure B.1



NOTE —  $w$  is the width of the toe piece contact area, in millimetres.

Figure B.2



NOTE —  $p_{E1}$  and  $p_{E2}$  are negligible if the measuring planes of the toe pieces are coated with hard carbide.

**Figure B.3**

## B.2 Numerical example

Firm	Number of drawing	Type of bearing
$d_{\text{cbm, th}} = \boxed{5} \boxed{4} \boxed{5} \boxed{2} \boxed{1}$ mm	$s_{\text{tot}} = \boxed{1} \boxed{9} \boxed{5} \boxed{0}$ mm	$B_{\text{max}} = \boxed{3} \boxed{5} \boxed{0} \boxed{0}$ mm
$F = \boxed{5} \boxed{8} \boxed{0} \boxed{0}$ N		$B_{\text{cbm1 or } B_{\text{cbm3, min}}} = \boxed{3} \boxed{5} \boxed{0} \boxed{0}$ mm
1 Actual peripheral length before correction (see figure B.1)		
$d_{\text{cbm, M}} \times \frac{\pi}{2} = \boxed{5} \boxed{4} \boxed{5} \boxed{2} \boxed{2} \times 1,5708 = \rightarrow \boxed{8} \boxed{5} \boxed{6} \boxed{4} \boxed{2} \boxed{9}$ mm		
2 Deviations $\Delta l_{\text{cbm1}}$ and $\Delta l_{\text{cbm2}}$ (take signs into account, see note under figure B.1)		
$\Delta l_{\text{cbm1}} = \boxed{-} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{1}$ mm		
$\Delta l_{\text{cbm2}} = \boxed{+} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{0}$ mm		
$\Sigma \Delta l_{\text{cbm}} = \boxed{-} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{1}$ mm	$\rightarrow$	$\boxed{-} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{1} \boxed{0}$ mm
3 Elastic variation: $\Delta H_{\text{cbm}} = \Delta H_{\text{cbm1}} + \Delta H_{\text{cbm2}}$ (see figure B.2)		
$\Delta H_{\text{cbm}} = \frac{H_{\text{cbm, th}} F}{2,5 \times 10^5 \times w B_{\text{cbm1}}} = \frac{\boxed{2} \boxed{7} \boxed{2} \boxed{6} \boxed{0} \times \boxed{5} \boxed{8} \boxed{0} \boxed{0}}{250\,000 \times \boxed{1} \boxed{0} \times \boxed{3} \boxed{5} \boxed{0} \boxed{0}} = \boxed{-} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{1} \boxed{8}$ mm		
4 Elastic depressions at both toe pieces (see figure B.3)		
$p_{E1} + p_{E2} = \frac{0,000\,03 F}{s_{\text{tot}} B} = \frac{0,000\,03 \times \boxed{5} \boxed{8} \boxed{0} \boxed{0}}{\boxed{1} \boxed{9} \boxed{5} \boxed{0} \times \boxed{3} \boxed{5} \boxed{0} \boxed{0}} = \boxed{+} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{2} \boxed{5}$ mm		
5 Measured peripheral length (after correction)		
$l_{\text{cbm, M}} = \Sigma (1 \text{ to } 4) = \boxed{+} \quad \boxed{8} \boxed{5} \boxed{6} \boxed{4} \boxed{2} \boxed{6}$ mm		
6 Theoretical peripheral length		
$l_{\text{cbm, th}} = d_{\text{cbm, th}} \times \frac{\pi}{2} = \boxed{5} \boxed{4} \boxed{5} \boxed{2} \boxed{1} \times 1,5708 = \rightarrow \boxed{-} \quad \boxed{8} \boxed{5} \boxed{6} \boxed{4} \boxed{1} \boxed{3}$ mm		
7 Correction factor for master checking block		
$F_{\text{cor, cbm}} = \boxed{+} \quad \boxed{0} \boxed{0} \boxed{0} \boxed{1}$ mm $\leftarrow \boxed{+} \quad \boxed{0} \boxed{0} \boxed{1} \boxed{3}$ mm		
Determine steps 1 and 2 by measurement.		

## Annex C (normative)

### Determination of the correction factor of the series checking block used alone

#### C.1 Determination of nip value in master checking block

C.1.1 Fit the master checking block in the measuring equipment.

C.1.2 Adjust the checking load  $F$  in accordance with the specifications.

C.1.3 Lower the measuring head with the toe piece onto the datum plane of the master checking block.

C.1.4 Set the correction factor ( $F_{\text{cor,cbm}}$ ) of the master checking block on the dial gauge under checking load  $F$ .

C.1.5 Place the half-bearing in the master checking block.

C.1.6 Apply the checking load  $F$  on the joint face(s) of the half-bearing.

C.1.7 Read the result,  $a_{\text{cbm,M}}$ , off the dial gauge.

#### C.2 Determination of nip value in series checking block

C.2.1 Fit the series checking block in the measuring equipment.

C.2.2 Set the same checking load  $F$  as in C.1.2.

C.2.3 Lower the measuring head with the toe piece onto the datum plane of the series checking block.

C.2.4 Set the dial gauge to zero under checking load  $F$ .

C.2.5 Fit the same half-bearing used in C.1.5 in the series checking block.

C.2.6 Apply the checking load  $F$  on the joint face(s) of the half-bearing.

C.2.7 Read the result,  $a_{\text{cbs,M}}$ , off the dial gauge.

#### C.3 Determination of correction factor

The difference between the two nip value readings in C.1.7 and C.2.7 is the correction factor:

$$F_{\text{cor,cbs}} = a_{\text{cbm,M}} - a_{\text{cbs,M}}$$

The  $F_{\text{cor,cbs}}$  value can be set on the dial gauge to a plus or minus indication.

#### EXAMPLE

If  $a_{\text{cbm,M}} = +40 \mu\text{m}$  and  $a_{\text{cbs,M}} = +45 \mu\text{m}$ , then

$$F_{\text{cor,cbs}} = 40 - 45 = -5 \mu\text{m}$$

and the dial gauge is set to  $-5 \mu\text{m}$ .

## Annex D (normative)

### Determination of the correction factor of the master shell or comparison shell

#### D.1 Peripheral length of master shell

The peripheral length of the master shell should be approximately equal to that of the half-bearing to be checked.

#### D.2 Calibration of master shell and determination of correction factor $F_{\text{cor,ms}}$

**D.2.1** Fit the master checking block in the measuring equipment.

**D.2.2** Adjust the checking load  $F$  in accordance with the specifications.

**D.2.3** Lower the measuring head with the toe piece onto the datum plane of the master checking block.

**D.2.4** Set the correction factor ( $F_{\text{cor,cbm}}$ ) of the master checking block on the dial gauge under checking load  $F$ , and keep it unaltered until checking is completed.

**D.2.5** Remove the measuring head with the toe piece from the master checking block.

**D.2.6** Place the master shell in the master checking block.

**D.2.7** Apply the checking load  $F$  on the joint face(s) of the master shell.

**D.2.8** Read the measuring result off the dial gauge; this is the correction factor,  $F_{\text{cor,ms}}$ , of the master shell.

**D.2.9** Engrave the correction factor  $F_{\text{cor,ms}}$  on the master shell.

#### D.3 Peripheral length of comparison shell

The peripheral length of the comparison shell should be approximately equal to that of the half-bearing to be checked.

#### D.4 Calibration of comparison shell and determination of correction factor $F_{\text{cor,cs}}$

**D.4.1** Fit the master checking block in the measuring equipment.

**D.4.2** Adjust the checking load  $F$  in accordance with specifications.

**D.4.3** Lower the measuring head with the toe piece onto the datum plane of the master checking block.

**D.4.4** Set the correction factor ( $F_{\text{cor,cbm}}$ ) of the master checking block on the dial gauge under checking load  $F$ , and keep it unaltered until checking is completed.

**D.4.5** Remove the measuring head with toe piece from the master checking block.

**D.4.6** Place the comparison shell in the master checking block.

**D.4.7** Apply the checking load  $F$  on the joint face(s) of the comparison shell.

**D.4.8** Read the measuring result off the dial gauge; this is the correction factor,  $F_{\text{cor,cs}}$ , of the comparison shell.

**D.4.9** Engrave the correction factor  $F_{\text{cor,cs}}$  on the comparison shell.

**Annex E**  
(normative)

**Tests and calculation of repeatability, reproducibility and comparability**

**E.1 Calculation of standard deviation of repeatability**

**E.1.1** Take and number 24 half-bearings ( $n = 24$ ).

**E.1.2** Place the first bearing in the checking block and measure it. Measure the remaining 23 bearings.

**E.1.3** In accordance with the checking conditions given in table 14, place the first bearing in the checking block to carry out a second measurement. Measure the remaining 23 bearings.

**E.1.4** Determine the difference  $\Delta l_i$  between the first and the second measurement of the individual bearings with correct signs.

**E.1.5** Calculate the standard deviation,  $\sigma_\Delta$ :

$$\sigma_\Delta = \sqrt{\frac{1}{n-1} \left[ \sum_{i=1}^n (\Delta l_i)^2 - \frac{1}{n} \left( \sum_{i=1}^n \Delta l_i \right)^2 \right]}$$

The repeatability of the checking method used is considered correct if

$$\sigma_\Delta \leq \sigma_{\Delta B} \text{ (see table 15)}$$

**NOTE 12**  $\sigma_\Delta$  is an estimate of the true standard deviation  $\sigma$ .

**E.2 Assessment of reproducibility**

The test is carried out as specified in E.1.1 and E.1.2, with a first set of measuring equipment, and then with a second set of measuring equipment, in accordance with the checking conditions given in table 14.

Calculate the mean value achieved with each set of measuring equipment:

$$\bar{x}_1 = \frac{\sum_{i=1}^n x_{1i}}{n} = \frac{1}{24} \sum_{i=1}^{24} x_{1i}$$

and

$$\bar{x}_2 = \frac{\sum_{i=1}^n x_{2i}}{n} = \frac{1}{24} \sum_{i=1}^{24} x_{2i}$$

The reproducibility of the method used is considered correct if

$$|\bar{x}_1 - \bar{x}_2| \leq \text{values given in table 15.}$$

**E.3 Assessment of comparability**

Test the accuracy of method A with method B as follows.

**E.3.1** Calculate  $\bar{x}_A$  (or  $\bar{x}_B$ ) as specified in E.2.

**E.3.2** Calculate  $\vec{x}_A$  (or  $\vec{x}_B$ ), the value of the nip measured with method B transposed to method A (or, reciprocally, with method A to method B):

$$\vec{x}_A = \bar{x}_B + \delta$$

$$\vec{x}_B = \bar{x}_A - \delta$$

where

$\bar{x}_B$  (or  $\bar{x}_A$ ) are calculated as specified in E.2;

$\delta$  is determined by the bearing manufacturer from the particular conditions of friction in the equipment.

**E.3.3** Calculate  $|\bar{x}_A - \vec{x}_A|$  (or  $|\bar{x}_B - \vec{x}_B|$ ).

The comparability is considered correct if the result is less than the value given in table 15.

**EXAMPLE**

Twenty-four half-bearings with an outside diameter of 100 mm are to be checked.

The recommended method of checking is method A (see table 1), which is specified on the drawing. Nevertheless, the manufacturer decides to apply method B.

The manufacturer measures the 24 bearings using method B and determines  $\bar{x}_B$ :

$$\bar{x}_B = \frac{\sum(a_{B1} + a_{B2})}{24} = 35 \mu\text{m}$$

The manufacturer determines empirically the correction  $\delta$  to be applied, for example 7  $\mu\text{m}$  (to be compared with the approximate value given in clause 7,

$$\tilde{\delta} = 0,7 \times 10^{-6} \times \frac{100 \times 9\,000}{2,25 \times 40} = 7 \mu\text{m}$$

and determines  $\bar{x}_A^*$ :

$$\bar{x}_A^* = 35 + 7 = 42 \mu\text{m}$$

When the customer receives the half-bearings, he/she carries out an acceptance test with the recommended method A and finds a mean nip value,  $a_{A,\text{mean}}$ , of

$$a_{A,\text{mean}} = + 50 \mu\text{m} = \bar{x}_A$$

Hence

$$|\bar{x}_A - \bar{x}_A^*| = 50 - 44 = 6 \mu\text{m}$$

Since  $6 < 14$  (see table 15), the accuracy is correct.

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